DWR OROVILLE FACILITIES RELICENSING PROJECT
(FERC Project No. 2100)

STUDY #3: EVALUATE THE POTENTIAL FOR ADDITIONAL HYDROPOWER GENERATION AT OROVILLE

November 15, 2001

1.0 INTRODUCTION/BACKGROUND

Hydroelectric energy is a renewable resource. Hydropower generation is an efficient (up to 95% efficiency) method of power generation. The existing Oroville facilities include major power generation facilities such as Edward Hyatt Power plant, Thermalito Power plant as well as small hydro powerplant at the Thermalito Diversion Dam.

Since the construction of Oroville Facilities in 1967, significant changes have taken place as discussed below:

- The present energy wholesale market is restructured and partially de-regulated while at the time of construction of the facilities it was a regulated market.

- After years of usage, wear and tear, the powerplants have experienced a small loss in hydro generation efficiency. This has caused a net reduction in electric energy produced from Oroville operations.

- The hydropower generation technology has improved significantly. This is particularly true for small hydro generation units, which take advantage of the run-of-the-river type of opportunities. The design of large turbine-generator units has also been improved to provide more efficient hydro generation.

- The Regulatory environment also changed since the construction of the original facilities, thus directly affecting Oroville flow operations.

- Power markets have recently entered a period of high volatility.

Potential opportunities to enhance hydropower generation are present. This study would review and evaluate the potential of such opportunities within Oroville project.

2.0 STUDY GOAL(S) AND OBJECTIVE(S)

The objective of this study is to evaluate past studies and determine if they should be updated, evaluate new or improved ways to generate additional hydropower or enhance the efficiency of power generation of the Oroville Facilities. The study would include evaluation of changes to the physical, infrastructure and/or operational aspects of the

Oroville Facilities and will incorporate recent and ongoing studies by DWR related to increased hydropower generation at Oroville.

3.0 RELATIONSHIP OF THE STUDY PLAN TO RELICENSING PROJECT PROCESS/PURPOSE AND NEED FOR THE STUDY

Relationship of the Study Plan to Relicensing Project Process

Water Supply and Hydroelectric power generations are two original project purposes of the Oroville Facilities (FERC Project 2100). The Federal Power Act requires FREC to consider: "The plans and abilities of the applicant to operate and maintain the project in a manner most likely to provide efficient and reliable electric service." (*TITLE 16-CONSERVATION, CHAPTER 12-FEDERAL REGULATION AND DEVELOPMENT OF POWER, SUBCHAPTER I-REGULATION OF THE DEVELOPMENT OF WATER POWER AND RESOURCES, Sec. 808: New licenses and renewals, (a) (2) (C))*

The study aims to provide information on the issue of efficient development of hydropower in the Oroville project, in support of the relicensing process.

The study also address the following specific issues identified in the scoping process:

Issue Statement No. E1: Evaluate the potential for adding additional generation using existing infrastructure, modifying facilities to increase storage and associated generation, and changing operation to provide spinning reserve (e.g., motoring).

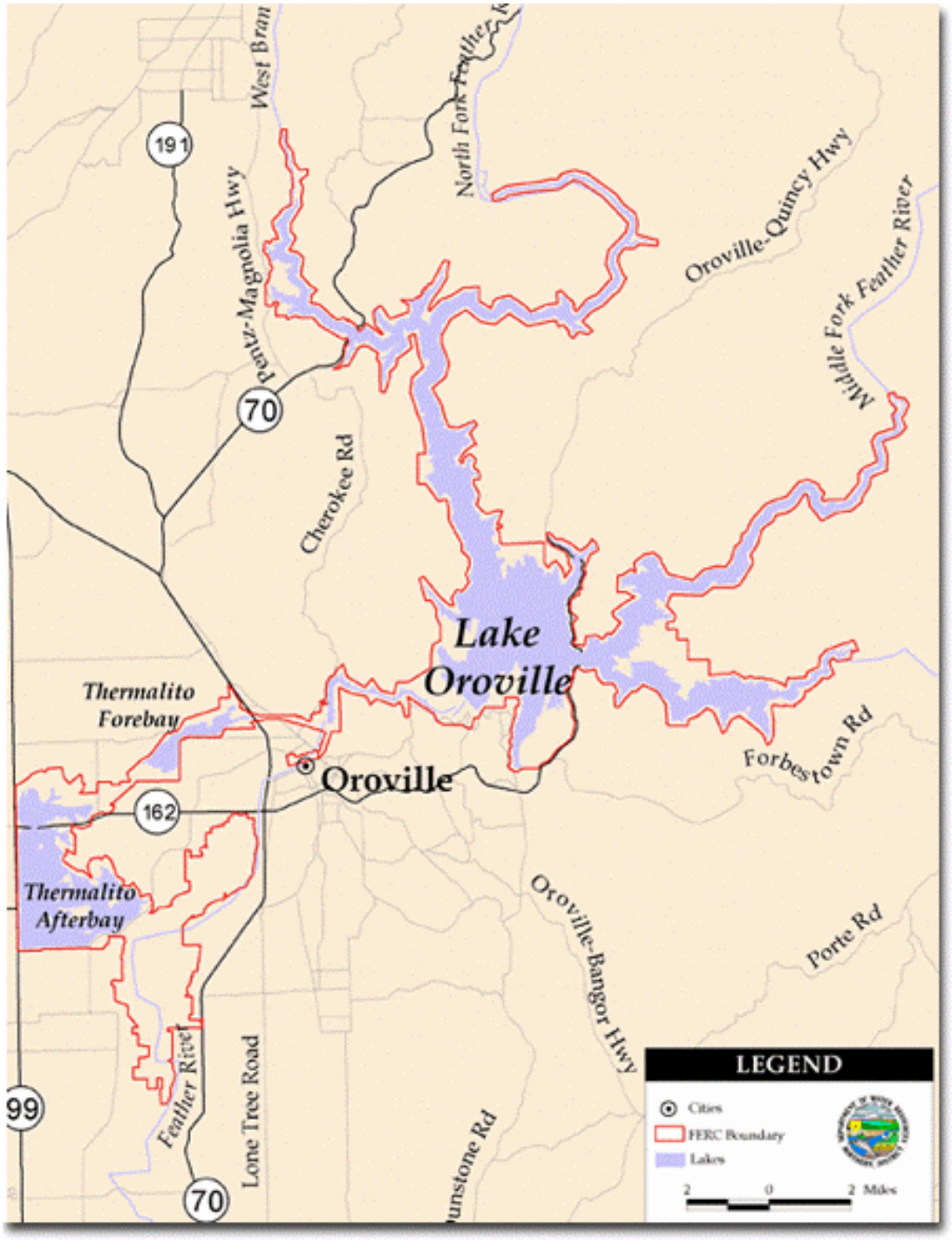
Issues Addressed
EE1. Consider adding additional generating capabilities (some existing infrastructure).
EE2. Intake on North side of dam - Afterbay outlet motoring to provide spinning reserve.
EE14. Potential physical changes to facility to increase storage and generation. Impacts to existing and potential facilities.

Purpose and Need for the Study

At present some current information on increased Hydropower generation capacity is available. This includes completed as well as "in-progress" studies. However, many of the existing studies are outdated as they were completed decades ago. Also, some new options for hydropower generation have been proposed that need evaluation. Therefore, the existing information, by itself, does not provide a suitable basis to satisfactorily explore the issue of "efficient development of hydropower". The proposed study would explore this issue in the light of current power market, technology, and regulatory requirements.

4.0 Scope – Study Area

Oroville Facilities within FERC project boundary



Map of Study Area: FERC Project 2100 Boundary.

5.0 GENERAL APPROACH

The general approach of the study would be to evaluate (a) the engineering and (b) the economic feasibility of various opportunities while considering:

- The water supply operations constraints,
- Current and projected electric power market conditions, and.
- The current technology of hydropower generation.

The study would identify possible major impacts of various options in the following areas:

- Water Supply
- Environmental Resources (Fisheries and Water Temperature)
- Recreation Resources
- Flood Protection

The study would evaluate both the major additional hydroelectric facilities as well as the incremental or run-of-the-river type of hydroelectric power projects.

Detailed Methodology and Analysis Procedures

Task 1 – Review existing literature on power generation of the Oroville Facilities.
The first task is to collect and review pertinent information on studies that have been completed:

Hydropower Studies Completed

1. Edward Hyatt Powerplant – Modernization (1997)
This study was completed in 1997 by DWR. After 30 years of use, the cavitation and wear-tear has damaged the Hyatt Powerplant Turbines. This was amply confirmed by inspections. Tests show the efficiency of the turbines has also dropped by 3%. The study recommended modernization of the units by replacing the turbine runners and increasing the generation efficiency as below:

- Units 2, 4, and 6: Boost the turbine's MW rating (89.484) to match the generator (98) based on model tests and increase wheel efficiency from 87.1% to 94%.
- Units 1,3, and 5: Increase the turbine efficiency from 89.9% to 95%.

DWR is currently in the process of implementing the recommendations of this study.

2. Sutter Butte Canal Outlet Small Hydro Plant Study 1981
Sutter Butte Canal Outlet, located on the Southern boundary of the Thermalito Afterbay, serves the requirements of several water districts. It consists of four 7-ft. wide by 6-ft.

high conduits. The annual average release of water from this outlet is about 650 cfs. with a head of 23 ft.

In 1981, DWR filed an application with FERC for the construction of a small hydro power plant at this outlet. The power plant included Kaplan turbine–generator unit (1.2 MW) on two of the conduits of the outlet. The powerplant was not constructed due to marginal economics.

3. Palermo Canal Outlet Small Hydro Plant Study- 1981

The Palermo Outlet Works Tunnel, is a 6-ft. diameter and 2,430 ft. long conduit located on the left abutment of Oroville Dam. The valve chamber and the energy dissipater are located just downstream of the Oroville Dam grout curtain. An open flume carries the water from the energy dissipater to the exit portal near the toe of the dam. The average annual release through Palermo Canal is 11 cfs.

In 1981 DWR filed an application with FERC for the construction of a small hydro powerplant at this outlet. The proposal included a 660 hp Francis turbine with a 500 KW Generator. However, the Powerplant was not constructed because the cost was higher than alternate source of energy.

4. Hyatt Powerplant-Operations during floods-1987

This partially completed study was undertaken to assure the safety of Hyatt Powerplant. It effected the hydropower capacity of the plant only during floods, not the normal conditions. During flood conditions, the tailrace elevation increases, (226.5-Ft. to 236-Ft.) affecting the discharge tunnel flow capacity. If the power units trip due to load rejection, a pressure wave would be generated in the discharge tunnel. The pressure does not build up if the tunnel is ventilated. However, if the tunnel is running full, the pressure can build to dangerous levels. The study made recommendations (draft) to limit the flow through the Powerplant as the tailrace elevation rises.

5. Oroville-Thermalito Power Complex Phase II.-2001

DWR carried out a Design Study of Oroville-Thermalito Power Complex Phase II in 1974. It was updated in a cursory manner in 2001. Phase II consists of Right Abutment Intake, 870 MW Oroville Power Plant II (6-145 MW units), 145 MW Thermalito Powerplant II (5-29 MW units), enlarged waterways and Thermalito Forebay, Expanded Thermalito Afterbay, and other associated works.

Hydropower Studies In-Progress

1. Thermalito Powerplant-Feasibility of refurbishment. 2001

The study was initiated by DWR in 2001 and is in progress. Its purpose is to evaluate the modifications to improve the efficiency of Kaplan Unit 1 at the Thermalito Powerplant. The Generator capacity of Kaplan Unit 1 is 34,316 KVA (32,600 kW).

The turbine was originally rated at:

Power	Net Head	Efficiency
45,000 (hp)	85-feet	90.0 percent
25,000 (hp)	95-feet	92.1 percent

However the efficiency (at rated head & optimum gate and blade angle) has deteriorated down to 84 percent.

Efficiency after refurbishing would increase to 91 percent. The improvements would increase energy generation (kilowatt-hours), not the generation capacity which is limited by the generator.

2. Thermalito Afterbay River Outlet Small Hydro Plant study-2001

DWR releases 400 to 17000 cfs (generally 4000-6000 cfs) of water from Thermalito Afterbay into Feather River with a head of 23 ft. In 1980, DWR completed a study of feasibility of a 13,000 Kilowatt hydropower plant using this outflow. However, the powerplant was not constructed due to construction issues and project economics.

The interest in hydropower generation from Thermalito Afterbay outflow was revived in 2001 due to the energy crisis in California. DWR is currently studying the feasibility of hydropower generation by installing the VA Tech Hydro modules, (about 1-MW capacity) in up to 4 of the 5 openings of the river outlet. These turbines are easier to install and have very little construction related environmental impact.

Task 2 – Update/Refine earlier studies

While some of the studies are currently underway or have been completed recently, others were done decades ago or might not have been sufficiently detailed. The studies would be updated and refined to reflect current conditions. The studies include:

1. Sutter Butte Canal Outlet Small Hydro Powerplant Study.
2. Palermo Canal Outlet Small Hydro Powerplant Study
3. Oroville-Thermalito Power Complex Phase 2.

Task 3 – Evaluate New Concepts

New concepts or proposals for hydroelectric power could be evaluated, including:

1. Hydroelectric power from Kinetic Energy of waters flowing in Thermalito Power Canal.

This study would evaluate the feasibility of installing a hydroelectric power unit in Thermalito Power Canal. The unit would be designed to convert the kinetic energy of flowing water into electric power. Such a facility would also interfere with the water flow.

Therefore, in addition to the engineering and economic feasibility, the study would consider the impact of such a unit on water supply.

2. Additional Hydropower generation at Thermalito Diversion Dam.
In 1984-86, DWR constructed a small hydro Powerplant to capture the energy of the flow released from Thermalito Diversion dam into the Feather River. It is rated for 3.3 MVA (3.14 MW) maximum power at 615-cfs flow and 67-Ft. dynamic head.

In addition to the water that runs the small hydro unit, water impounded by the radial gates on Thermalito Diversion Dam is also released, although not regularly, into Feather River to meet various flow and storage requirements. The proposed study would investigate the feasibility of power generation from the water released by the Thermalito Diversion Dam radial gates.

3. Increase spinning reserve by motoring the units.
Spinning Reserve is the portion of unloaded synchronized generating capacity, controlled by the ISO, which is capable of being loaded in 10 minutes, and which is capable of running for at least two hours. California ISO is required by the Western Systems Coordinating Council to maintain a minimum spinning reserves.

This spinning reserve generation capacity has a different market and economics. This study would investigate the feasibility of using the hydroelectric generator(s) in Oroville-Thermalito Complex to provide this marketable spinning reserve. This may be accomplished by, for instance, motoring the unit to keep it spinning at synchronized frequency and generating hydroelectric power on demand from CAISO.

Task 4– Report
A report will be prepared summarizing the work in each task.

6.0 RESULTS AND PRODUCTS/DELIVERABLES

Results

The results of the study would consist of identification, assessment of quantitative and qualitative significance and a thorough discussion of the factors affecting the feasibility of various options for additional hydro generation at Oroville Facilities. These factors would include:

- Engineering
- Economics
- Environmental Impacts, including Fisheries, Water Temperature
- Recreation
- Regulatory Environment
- Water Supply

Products/Deliverables

The product of this study will be a comprehensive report evaluating the feasibility of each option to enhance the hydroelectric power generation of the Oroville Facilities. The report would not identify any preferred option, rather it would present a spectrum of major issues, fatal flaws, benefits, and costs for various options.

7.0 STUDY PLAN COORDINATION AND IMPLEMENTATION STRATEGY

Coordination with Other Resource Areas/Studies

This study does not provide input to, nor does it require input from any other study of the relicensing process. However, as indicated in Sec. 6, the effects of hydrogenation options on other resource areas would be considered.

Within DWR, the following organizations would be cooperating in the study:

- Division of Engineering
- Division of Operation and Maintenance
- State Water Project Analysis Office

Study Plan Tracking/Regulatory Compliance Requirements

The relicensing process requires that issues identified in the scoping process must be addressed. The study addresses issue E1: "Evaluate the potential for adding additional generation using existing infrastructure, modifying facilities to increase storage and associated generation, and changing operation to provide spinning reserve (e.g., motoring) (Issues addressed: EE 1, 2, and 14))". Every option of additional hydrogenation would be studied to address this issue.

8.0 REFERENCES

Provide a complete list of references with full citations of literature cited or used in completion of the study.

ATTACHMENTS (EXAMPLES)

A- RELEVANT STAKEHOLDER/WORK GROUP ISSUE SHEET(S)
B- ORIGINAL COMMENTS PROVIDED BY STAKEHOLDERS ADDRESSED BY THE STUDY PLAN
C - DATA COLLECTION/FIELD SURVEY DATA SHEETS
D - DATABASE TEMPLATES
E - SUMMARY REPORT - ANNOTATED OUTLINE

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STUDY PLAN IMPLEMENTATION ISSUES
DWR FILE/TEAR SHEET TEMPLATE

October 1, 2001

Study Plan Resources

Identify agency personnel, equipment, and other resources needed to successfully implement all phases of the study plan. State anticipated need for resource specialists or technical consultants in the completion of the study plan. Present as hours by task by staff/expert.

Study Plan Implementation Schedule

Identify the anticipated schedule for completion of study plan tasks, draft and final product(s). Provide timeline indicating inter-relationship of study plan tasks with key milestones for individual tasks.

Study Plan Implementation Costs

Determine and present start-up and on-going costs associated with all phases of study plan implementation. Identify anticipated funding sources and mechanisms.